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Notes:
1. Untranslatable words are replaced with asterisks (****).
2. Texts in the figures are not translated and shown as it is.

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[Claim(s)]

[Claim 1] A means to make a sample produce a magnetic resonance phenomenon and to generate a magnetic resonance signal, The 1st which receives the magnetic resonance signal generated from said sample, and 2nd RF coil, being based on the signal received with said 1st RF coil -- the 1st base -- being based on the signal which generated the picture and was received with said 2nd RF coil -- the 2nd base -- the base which generates a picture -- [means / picture generation] said base -- the 1st and 2nd base generated by the picture generation means -- [means / to compute global distribution of the signal strength ratio of a picture / calculation] the 1st and 2nd base computed by said calculation means -- being based on global distribution of the signal strength ratio of a picture -- the 1st and 2nd base concerned -- the magnetic resonance imaging system characterized by providing a synthetic means to compound a picture.

[Claim 2] said base -- the 1st and 2nd base generated by the picture generation means -- the base which smooths a picture -- [a picture smoothing means is provided further and / said calculation means] said base -- the 1st and 2nd base smoothed by the picture smoothing means -- the magnetic resonance imaging system according to claim 1 characterized by computing global distribution of a signal strength ratio from a picture.

[Claim 3] the 1st and 2nd base computed by said calculation means -- the magnetic resonance imaging system according to claim 1 characterized by providing further a smoothing means to smooth global distribution of the signal strength ratio of a picture.

[Claim 4] the 1st and 2nd base computed by said calculation means -- [said synthetic means] when setting global distribution of the signal strength ratio of a picture to K said 1st base -- setting the relative weighting to a picture to 1 -- said 2nd base -- the magnetic resonance imaging system according to claim 1 to 3 characterized by compounding the relative weighting to a picture as said K.

[Claim 5] the 1st and 2nd base computed by said calculation means -- [said synthetic means] when setting global distribution of the signal strength ratio of a picture with K and setting the arbitrary functions about this K to f (K) said 1st base -- making the weighting to a picture into f (K)/(1+K2) -- said 2nd base -- the magnetic resonance imaging system according to claim 1 to 3 characterized by compounding the weighting to a picture as K-f(K)/(1+K2).
[Claim 6] A magnetic resonance imaging system given in either Claim 4 characterized by the arbitrary values of function f (K) about said K being about 1, or Claim 5.
[Claim 7] A means to make a sample produce a magnetic resonance phenomenon and to generate a magnetic resonance signal, In the magnetic resonance imaging system which possesses a synthetic means to compound the last picture, based on the signal received with two or more RF coils which receive the magnetic resonance signal generated from said sample, and said two or more RF coils Provide further a calculation means to compute the amount of weightings based on the signal received with said two or more RF coils, and [said synthetic means] By performing weighting addition according to the amount of weightings computed by said calculation means The magnetic resonance imaging system characterized by global distribution of the signal strength compounding the last picture which becomes almost equivalent to global distribution of the signal strength obtained only with RF coil of any 1 among said two or more RF coils.
[Claim 8] The magnetic resonance imaging system according to claim 7 characterized by providing further the means which makes it selectable how much to bring global distribution of the signal strength of said last picture close to global distribution of the signal strength of which RF coil of said two or more RF coils.
[Claim 9] Said two or more RF coils are magnetic resonance imaging systems given in either Claim 7 characterized by bringing global distribution of the signal strength of said last picture close to this volume coil, or Claim 8 including a volume coil with globally uniform sensitivity distribution.
[Claim 10] A means to make a sample produce a magnetic resonance phenomenon and to generate a magnetic resonance signal, The 1st which receives the magnetic resonance signal generated from said sample, and 2nd RF coil, being based on the signal received with said 1st RF coil -- the 1st base -- being based on the signal which generated the picture and was received with said 2nd RF coil -- the 2nd base -- the base which generates a picture -- [means / picture generation] the 1st and 2nd base generated by said generation means -- [a picture / means / to amend by the ratio of the noise standard deviation / amendment] the 1st and 2nd base amended by said amendment means -- [means / to compute global distribution of the signal strength ratio of a picture / calculation] the 1st and 2nd base computed by said calculation means -- being based on global distribution of the signal strength ratio of a picture -- the 1st and 2nd base concerned -- the magnetic resonance imaging system characterized by

providing a synthetic means to compound a picture.
[Claim 11] Said amendment means is a magnetic resonance imaging system according to claim 10 characterized by asking for the ratio of said noise standard deviation by the ratio of the noise standard deviation of the corner part of k space data.
[Claim 12] said amendment means -- the ratio of said noise standard deviation -- base -- the magnetic resonance imaging system according to claim 10 characterized by asking by the ratio of the standard deviation of the corner part of a picture.
[Claim 13] A means to make a sample produce a magnetic resonance phenomenon and to generate a magnetic resonance signal, The 1st which receives the magnetic resonance signal generated from said sample, and 2nd RF coil, being based on the signal received with said 1st RF coil -- the 1st base -- being based on the signal which generated the picture and was received with said 2nd RF coil -- the 2nd base -- the base which generates a picture -- [means / picture generation] said base -- the 1st and 2nd base generated by the picture generation means -- [means / to compound a picture / synthetic] smoothing the synthetic picture compounded by said synthetic means -- said base -- the 1st base generated by the picture generation means -- [means / to smooth a picture / smoothing] the synthetic picture smoothed by said smoothing means in the synthetic picture compounded by said synthetic means, and the 1st base -- the magnetic resonance imaging system characterized by providing an amendment means to amend based on a ratio with a picture.

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a magnetic resonance imaging system (it may be hereafter called MRI equipment for short).
[0002]
[Description of the Prior Art] The phased array coil is briskly used as a RF coil of MRI equipment in recent years. This example is Reference-documents:P.Roemer, "The NMR Phased Array", and Magnetic Resonance in Medicine 16,192-225 (1990). It is indicated. Here, the data which has arranged two or more RF coils near the sample, received MR signal from a sample simultaneously with these two or more RF coils, and was received with each RF coil was compounded, and the last picture has been obtained.
[0003] When two or more RF coils receive compared with the case where only single RF coil receives, there is an advantage that a wide range photography view can be acquired. however, [the picture (the following and base -- a picture is called) obtained by reconstructing the data received in each of two or more RF coils / only only carrying out addition composition] There is

the opposite side that the signal to noise ratio (SNR:Signal to Noise Ratio may be called hereafter) of the last picture compounded and obtained falls. Then, while obtaining a signal to noise ratio equivalent to single RF coil not by mere addition composition but by special weighting addition, generally attaining the large sensitivity field which consists of the sum of the photography field of two or more RF coils is performed. That is, generation of the synthetic picture by the above mentioned Reference documents will be performed as follows, if it is the two number of RF coils, for example. the base obtained from the RF coils 1 and 2 by the usual image reconstruction method -- setting a picture to each M1 and M2 -- the following formula (1) Weighting addition is carried out by dignity W1 and W2 so that it may be shown, and the synthetic picture M is obtained.

[0004] M=W1, M1+W2, andM2 -- (1) Here, although each of M, M1, M2, W1, and W2 is the functions of the pixel positions i and j in a picture matrix, should attach the suffix of Original i and j and should write that, they omits this for convenience on these Descriptions.

[0005] As a method of defining dignity W1 and W2, it divides roughly and two methods are known. The method which is first called the sum OBU square (Sum of Squares) method and which is used most ordinarily is described. Only M1 and M2 are used by this method, and it is a formula (2). As shown in (3), W1 and W2 are defined.

[0006]

[Mathematical formula 1]

$$W1 = \frac{M1}{\sqrt{M1^2 + M2^2}} \quad \cdots (2)$$

[0007]

[Mathematical formula 2]

$$W2 = \frac{M2}{\sqrt{M1^2 + M2^2}} \quad \cdots (3)$$

[0008] And formula (2) Formula (3) Formula (1) It is a formula (4) when it substitutes and arranges. Finally M becomes the square sum of M1 and M2 so that it may be shown. This is the reason to which this method is called the sum OBU square method.

[0009]

[Mathematical formula 3]

$$M = \sqrt{M1^2 + M2^2} \quad \cdots (4)$$

[0010] This sum OBU square method has the problem that it explains below. Drawing 9 is the figure showing typically RF coil of the plurality (here two) for collecting MR signals from a sample simultaneously. The 1st RF coil C1 is formed so that Subject M may be surrounded, and it is a volume coil in which the sensitivity distribution is comparatively uniform. As a volume

coil, a saddle coil and a birdcage coil are well-known, and there are a thing for the whole body embedded at a mount (not shown), a thing twisted around the trunk part of a subject, etc. The 2nd RF coil C2 is a surface coil (surface coil) prepared in the lower part (right under) of Subject M. The neighborhood is high SNR by high sensitivity, and a surface coil has the characteristic that sensitivity falls as it keeps away far away, and SNR falls.

[0011] The cylindrical middle signal level substance m1 which appears as a signal of uniform in-between intensity when appearance carries out imaging of the subject M which makes the shape of a cylinder by magnetic resonance imaging, When imaging is similarly carried out to the cylindrical non-signal cavernous part (for example, air) m2 with which it filled up into m1, it consists of cylindrical Takanobu number level substances m3 which appear as a signal of high intensity. In the state where there is no noise, if imaging of the AKISHARU section of the subject M concerned is completely carried out with uniform RF coil, signal strength will become distribution like drawing 10 ideally. The vertical axis of three-dimensions graph shown in this figure is a picture signal level.

[0012] [with now, two RF coils (the 1st RF coil C1 and 2nd RF coil C2)] Receive in simultaneous parallel and MR signal from Subject M [data / two / k space] each base corresponding to two RF coils -- if a picture M1 and M2 are obtained by the usual image reconstruction and these matter pictures M1 and M2 are compounded by the sum OBU square method, the picture signal level of the synthetic picture obtained will become distribution like drawing 11 . In drawing 11 , the 2nd RF coil C2 is formed in this side right-hand side of this figure three-dimensions graph. According to the sum OBU square method, SNR almost near the best SNR obtained in the combination of M1 and M2 is obtained throughout a picture. However, it sets into the portion (this side right-hand side of this figure three-dimensions graph) near the 2nd RF coil C2. It is extremely high to the same extent as the case where a picture signal level is independently obtained with this coil, and low in a portion (back left-hand side of this figure three-dimensions graph) far from this coil to the same extent as the case where a picture signal level is independently obtained with the 1st RF coil C1. Such a picture is very inconvenient when using.

[0013] the base obtained with two or more RF coils -- as the concrete purpose for spending of the synthetic picture which compounded and obtained the picture For example, although the survey of the circumference of the 2nd RF coil C2 is broadly carried out with the 1st RF coil 1 for the purpose, such as investigating whether the 2nd RF coil C2 is installed in the portion near a tumor, for example, there is any transition to the lymph gland of this tumor Since the dynamic range of the picture signal level of the synthetic picture obtained based on the sum OBU square method serves as size so that clearly from this figure, if change various window levels at the time of picture observation and they are not investigated, there is a problem that a possibility of overlooking a pathological change becomes high. Moreover, since it is necessary

to set up and output many window levels also about the case where a hard copy is photographed on a film and many films are needed to one picture, it is uneconomical.
[0014] Furthermore, since the sensitivity homogeneity of the coil itself [this] is bad near the 2nd RF coil C2, it is hard to see too, and this is also the Reason a surface coil (here 2nd RF coil C2) is seldom used abundantly, originally, although SNR is good.
[0015] On the other hand, unlike the sum OBU square method, as other methods of defining dignity W1 and W2, sensitivity distribution of two RF coils is held as prior information, and there is a method (classified into the further various methods as detailed) of using it. Although the detailed explanation about this method is omitted, according to this method, homogeneous amendment of the last composition picture is possible to a considerable grade based on the sensitivity distribution information on RF coil.
[0016] However, [in using the sensitivity distribution information on RF coil obtained in advance] The system which performs picture composition calculation must grasp correctly coil to the field which performs imaging, among two or more RF coils, which RF coil separates what distance to direction of which, and is installed in. This is a very inconvenient thing. Then, if the place and direction which install RF coil to a photography field are limited, use of sensitivity distribution information will become easy. However, it is the direction considered to be the best for the place considered for a surface coil (2nd RF coil C2 shown by drawing 9) to be the best for diagnosing a pathological change part, for example, and since it is installed according to a situation, such limitation is not desirable.
[0017] Moreover, even if it is going to detect the place of a surface coil, and direction correctly, it will become large-scale [the equipment for it], and big-ticket, and what was materialized is not yet offered. Furthermore, if it says and the static magnetic field intensity of MRI equipment is high, a sensitivity distribution pattern changes for every subject under the influence of a subject, and this method of using the sensitivity distribution information on RF coil which this also obtained in advance is made impractical.
[0018] MRI
[Problem to be solved by the invention] In the magnetic resonance imaging system compounded with the conventional technique of having mentioned above the picture obtained with two or more RF coils (1) when based on the sum OBU square method While it has the advantage that the picture which has the best SNR which can be obtained by composition of the picture which two or more RF coils boiled, respectively, and was obtained more is compoundable, [sensitivity distribution of each RF coil, especially sensitivity distribution / with the influence of uneven RF coil] There is a problem that distribution of the picture signal level of a synthetic picture will be uneven.
[0019] Moreover, (2) In order to acquire the sensitivity distribution information on each RF coil in advance and to compound based on this distribution information, a system needs to grasp

the information about a setting position, a direction, etc. of RF coil, and there is a problem that this is not practical.

[0020] This invention was made that such a situation should be coped with, and The sensitivity distribution characteristic, and [picture / which several RF coils with which the SNR characteristics differ boiled, respectively, and was obtained more] [the picture which has homogeneity with the homogeneity of sensitivity distribution equivalent to RF coil of the better one, and has the best SNR which can be obtained by composition of the picture which two or more RF coils boiled, respectively, and was obtained more] It aims at offering a compoundable magnetic resonance imaging system, without using the sensitivity distribution information on RF coil obtained in advance.

[0021]

[Means for solving problem] [the magnetic resonance imaging system of this invention according to claim 1] A means to make a sample produce a magnetic resonance phenomenon and to generate a magnetic resonance signal, The 1st which receives the magnetic resonance signal generated from said sample, and 2nd RF coil, being based on the signal received with said 1st RF coil -- the 1st base -- being based on the signal which generated the picture and was received with said 2nd RF coil -- the 2nd base -- the base which generates a picture -- [means / picture generation] said base -- the 1st and 2nd base generated by the picture generation means -- the 1st and 2nd base computed by a calculation means to compute global distribution of the signal strength ratio of a picture, and said calculation means -- being based on global distribution of the signal strength ratio of a picture -- the 1st and 2nd base concerned -- it is characterized by providing a synthetic means to compound a picture.

[0022] [the magnetic resonance imaging system of this invention according to claim 7] A means to make a sample produce a magnetic resonance phenomenon and to generate a magnetic resonance signal, In the magnetic resonance imaging system which possesses a synthetic means to compound the last picture, based on the signal received with two or more RF coils which receive the magnetic resonance signal generated from said sample, and said two or more RF coils Provide further a calculation means to compute the amount of weightings based on the signal received with said two or more RF coils, and [said synthetic means] By performing weighting addition according to the amount of weightings computed by said calculation means, global distribution of the signal strength is characterized by compounding the last picture which becomes almost equivalent to global distribution of the signal strength obtained only with RF coil of any 1 among said two or more RF coils.

[0023] [the magnetic resonance imaging system of this invention according to claim 10] A means to make a sample produce a magnetic resonance phenomenon and to generate a magnetic resonance signal, The 1st which receives the magnetic resonance signal generated from said sample, and 2nd RF coil, being based on the signal received with said 1st RF coil --

the 1st base -- being based on the signal which generated the picture and was received with said 2nd RF coil -- the 2nd base -- the base which generates a picture -- [means / picture generation] the 1st and 2nd base generated by said generation means -- [a picture / means / to amend by the ratio of the noise standard deviation / amendment] the 1st and 2nd base amended by said amendment means -- [means / to compute global distribution of the signal strength ratio of a picture / calculation] the 1st and 2nd base computed by said calculation means -- being based on global distribution of the signal strength ratio of a picture -- the 1st and 2nd base concerned -- the magnetic resonance imaging system characterized by providing a synthetic means to compound a picture.

[0024] [the magnetic resonance imaging system of this invention according to claim 13] A means to make a sample produce a magnetic resonance phenomenon and to generate a magnetic resonance signal, The 1st which receives the magnetic resonance signal generated from said sample, and 2nd RF coil, being based on the signal received with said 1st RF coil -- the 1st base -- being based on the signal which generated the picture and was received with said 2nd RF coil -- the 2nd base -- the base which generates a picture -- [means / picture generation] said base -- the 1st and 2nd base generated by the picture generation means -- [means / to compound a picture / synthetic] smoothing the synthetic picture compounded by said synthetic means -- said base -- the 1st base generated by the picture generation means -- [means / to smooth a picture / smoothing] the synthetic picture smoothed by said smoothing means in the synthetic picture compounded by said synthetic means, and the 1st base -- it is characterized by providing an amendment means to amend based on a ratio with a picture.

[0025]

[Mode for carrying out the invention] With reference to Drawings, one embodiment of the magnetic resonance imaging system by this invention is explained hereafter. Drawing 1 is the block diagram showing the outline composition of this embodiment. In a gantry 20, the static magnetic field magnet 1, the X-axis, the Y-axis and Z shaft inclination slanting magnetic field coil 2, and the ****** coil 3 that consists of two RF coils are formed.

[0026] The static magnetic field magnet 1 as a static magnetic field generator is constituted using for example, a superconductivity coil or a usual state conduction coil. The X-axis, the Y-axis, and Z shaft inclination slanting magnetic field coil 2 are coils for generating X shaft inclination slanting magnetic field Gx, Y shaft inclination slanting magnetic field Gy, and Z shaft inclination slanting magnetic field Gz. The ****** coil 3 is used in order to detect the magnetic resonance signal (MR signal) which generated the high frequency (RF) pulse as a selection excitation pulse for choosing a slice, and was generated by magnetic resonance. The subject M laid on the top plate of a bed 13 is inserted in the imaging feasible region in a gantry 20 (it is the spherical field in which the magnetic field for imaging is formed, and diagnosis becomes possible only in this field).

[0027] The static magnetic field magnet 1 is driven with the static magnetic field control device 4. The ****** coil 3 is driven with the transmitting machine 5 at the time of excitation of magnetic resonance, and is combined with a receiver 6 at the time of detection of a magnetic resonance signal. The X-axis, the Y-axis, and Z shaft inclination slanting magnetic field coil 2 are driven by X shaft inclination slanting magnetic field power supply 7, Y shaft inclination slanting magnetic field power supply 8, and Z shaft inclination slanting magnetic field power supply 9.

[0028] X shaft inclination slanting magnetic field power supply 7, Y shaft inclination slanting magnetic field power supply 8, Z shaft inclination slanting magnetic field power supply 9, and the transmitting machine 5 are driven according to a predetermined sequence by a sequencer 10, and generate X shaft inclination slanting magnetic field Gx, Y shaft inclination slanting magnetic field Gy, Z shaft inclination slanting magnetic field Gz, and a high frequency (RF) pulse in a predetermined pulse sequence. In this case, X shaft inclination slanting magnetic field Gx, Y shaft inclination slanting magnetic field Gy, and Z shaft inclination slanting magnetic field Gz are used, respectively, for example as the gradient magnetic field germanium for phase encoding, the gradient magnetic field Gr for read-out, and a gradient magnetic field Gs for a slice mainly. By taking in the magnetic resonance signal received with a receiver 6, and giving predetermined signal processing, computer systems 11 generate the tomogram for a subject, and display it in the display part 12 while they carry out drive control of the sequencer 10.

[0029] this embodiment -- an outline -- it is constituted as mentioned above. By the way, the ****** coil 3 consists of the 2nd RF coil C2 in two RF coils C1, i.e., 1st RF coil, like drawing 9 shown above. Here, the 1st RF coil C1 is used for transmission and reception, and the 2nd RF coil C2 presupposes that it uses only at the time of reception. That is, C1 is used at the time of transmission, and C1 and C2 are used at the time of reception. In addition, there is a RF coil only for transmission in addition to C1 and C2, transmission is presented with it, and though C1 and C2 are used for reception, the meaning of this invention does not change. Moreover, reception may have the coil of the 3rd [**] and 4th grade so that a modification may explain. In addition, transmission may be presented also with C2 and the meaning of this invention does not change to the purpose for spending whose intensity distribution of the high frequency pulse of transmission may be uneven even in such a case.

[0030] With the 1st RF coil C1, if imaging of the subject of drawing 9 is actually carried out, it will become like drawing 2. Although a picture signal level is uniform, the influence of the noise superimposed on each signal is remarkable. If imaging is carried out with the 2nd RF coil C2, it will become like drawing 3. Since the neighborhood of the 2nd RF coil C2 (this side right-hand side of this figure three-dimensions graph, field of S19-S25) is high sensitivity, its SNR is high even if noise comparable as the 1st RF coil C1 superimposes it. However, from

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the 2nd RF coil C2, it takes for keeping away far away more (the back left-hand side of this figure three-dimensions graph, field of S1-S7), and SNR is inferior.

[0031] now -- these two RF coils receive MR signal from Subject M in simultaneous parallel -- image reconstruction usual from two k space data -- each base -- a picture M1 and M2 are obtained. base -- a picture M1, M2, and M obtained by carrying out synthetic processing of these like this embodiment are what is called absolute value pictures (magnitude picture). Moreover, in this embodiment, it is considered that M1 and M2 have comparable noise standard deviation respectively. two base -- in order to obtain the picture of the best SNR combining a picture M1 and M2, by this embodiment, dignity W1 and W2 are defined, as shown in a formula (5). Although the dignity W1 in case the noise of M1 and M2 has correlation, and W2 differ from a formula (5) correctly, they can be regarded as generally a formula (5) being materialized.

[0032]

[Mathematical formula 4]

$$\frac{W2}{W1} = \frac{\langle M2 \rangle}{\langle M1 \rangle} \qquad \cdots (5)$$

[0033] <M1> and <M2> are M1 when repeating picture photography many times, and the average of M2 respectively. In addition, the sum OBU square method mentioned above is filling this relation. Although there are restrictions of an upper type about the ratio of W2 to W1, about the size of W2 and W1, flexibility still remains. By changing this size of W1 and W2, signal strength distribution of a synthetic picture can be brought close to it of one of RF coils. It aims at bringing close to the uniform signal strength distribution which the RF coil C1 has in this embodiment. Here, the ratio of <M2> to <M1> is placed with K, as shown in a formula (6) (this "K" differs from "k" of k space).

[0034]

[Mathematical formula 5]

$$\frac{\langle M2 \rangle}{\langle M1 \rangle} = K \qquad \cdots (6)$$

A formula (7) will be obtained by an above-mentioned formula (1) and an above-mentioned formula (6) if it does so.

[0035]

[Mathematical formula 6]

$$M = W1\left(\langle M1 \rangle + e1\right) + \frac{\langle M2 \rangle}{\langle M1 \rangle} W1\left(\langle M2 \rangle + e2\right) \qquad \cdots (7)$$

[0036] Since M1 and M2 by noise are unsteady, and e1 and e2 are parts and they unsteady focusing on <M1> and <M2> here, the average value is zero. The average value <M> of M

when repeating photography many times becomes like a formula (8) about picture photography and composition.

[0037]

[Mathematical formula 7]

$$\langle M\rangle = W1\langle M1\rangle + \frac{\langle M2\rangle}{\langle M1\rangle} W1\langle M2\rangle$$

$$= W1\langle M1\rangle + K\,W1\,K\langle M1\rangle$$

$$= W1\langle M1\rangle\left(1+K^{2}\right) \quad \cdots (8)$$

[0038] By the way, <M> is equal to the distribution pattern (a signal distribution pattern may be called hereafter) of the picture signal level which removed the noise ingredient from M, and expresses this in <M1> as function [of a request of K] f (K) like the following formula (9).

[0039] <M>=f <(K) M1> If it (9) --9 Does so, as shown in the following formula (10) and (11), W1 and W2 which fill both a formula (8) and (9) can be found.

[0040]

[Mathematical formula 8]

$$W1 = \frac{f(K)}{1+K^{2}} \quad \cdots (10)$$

[0041]

[Mathematical formula 9]

$$W2 = \frac{K\,f(K)}{1+K^{2}} \quad \cdots (11)$$

[0042] In addition, selection of f (K) is arbitrary. What is necessary is to just be referred to as f (K) =1 if you want to make the signal distribution pattern of the last picture M especially be the same as that of <M1>. Moreover, although [in defining K] asked from <M1> and <M2> which repeated and obtained many photography, it is unreal to actually repeat many photography. Then, M1 obtained by one photography and the thing which obtained M2 by having smoothed them respectively are used as <M1> and <M2>. Since it is expected that spatial noise distribution and time noise distribution are equivalent (there is ergodicity), this substitution is appropriate.

[0043] <M1> which smoothed and obtained M1 obtained as data of the 1st RF coil C1 is shown in drawing 4 , and <M2> which smoothed and obtained M2 obtained as data of the 2nd RF coil C2 is shown in drawing 5 . In addition, each of M1 and M2 is smoothed with the same smoothing function here.

[0044] Division of both is done (<M2>/<M1>), and ****** K is shown in drawing 6 based on <M1> and <M2> which were shown by drawing 4 and drawing 5 . Even if the value of <M1>

smooths even if and does division in the non-signal field which serves as zero mostly, the value of K flusters, as shown in this figure, but this does not interfere. In addition, in asking for K, not the formula (5) mentioned above but the following type (12) is used here.

[0045]

[Mathematical formula 10]

$$K = \frac{<M2>}{<M1> + C} \quad \cdots (12)$$

[0046] In an upper type, C is a positive small constant, and in the field in which the photographic subject which takes out a signal does not exist, it is added in order for the denominator of division to serve as zero or to avoid that a division result may show unusual high **. Although it is desirable for it not to be necessary to take into consideration and to make the value of C into a value smaller than <M1> of the field where a signal exists about the field concerned as for the picture of the field where the source of a signal does not exist, it does not need to pay consideration beyond it and is good as comparatively arbitrary.

[0047] The signal strength distribution pattern of the last composition picture obtained from K and f(K) =1 at a ceremony 1 with the application of W1 and W2 which were obtained by a formula (10) and (11) is shown in drawing 7 . As shown in this figure, according to this embodiment, the last composition picture which has the same distribution of SNR as the sum OBU square method which has a uniform signal strength distribution pattern as well as the 1st RF coil C1 shown in drawing 2 , and was shown in drawing 11 is generable.

[0048] Here describes the various modifications in this embodiment.

(a) although [<M1> and <M2>] M1 obtained from k space data by the usual image reconstruction and M2 are smoothed and calculated Since M1 and M2 are required in order to present M=W1, M1+W2, and M2, it in order [then,] to calculate <M1> and <M2> which shall carry out and define W1 and W2 It is good also as <M1> and <M2> respectively in the picture of the resolution between low altitudes which did not smooth M1 and M2, but reconstructed and obtained only k space data of the small field near [both the amount of phase encodings and whose amount of frequency encodings are smallness among k space data] the center. This method shall also be included with smoothing in this invention.

(b) sensitivity distribution of RF coil (1st RF coil C1) of 1 -- high -- although the case of being uniform was explained -- sensitivity distribution -- high -- it is not necessary to provide uniform RF coil inevitably That is, this method can be applied to obtain the last picture (synthetic picture) near the sensitivity distribution pattern of one of RF coils among two or more RF coils even if the sensitivity pattern of the RF coil is not uniform.

(c) being referred to as f(K) =1 -- high -- although what obtains the picture which has the same global signal strength distribution as the 1st uniform RF coil C1 as the last picture was explained, there is optionality in selection of f (K). For example, if f (K) is chosen like the

following formula (13), the last picture composition result will become being almost the same as that of the sum OBU square method mentioned above.

[0049]

[Mathematical formula 11]

$$f(K) = \sqrt{1 + K^2} \qquad \cdots (13)$$

[0050] By the way, there is a case where he wants to obtain the last picture which can grasp easily where [on a picture] it had moderate homogeneity and the surface coil (here 2nd RF coil C2) of high SNR is put. In this case, if f (K) is defined, for example like the following formula (14), it will have moderate homogeneity and the picture of the Takanobu number will be moderately obtained for the portion near the 2nd RF coil C2 rather than other portions.

[0051]

[Mathematical formula 12]

$$f(K) = \sqrt{K} \qquad \cdots (14)$$

[0052] In addition, since selection of f (K) is arbitrary, it is arbitrary how much the sensitivity distribution pattern of the last picture composition result is brought close to the sensitivity distribution pattern of which RF coil.

(d) Although the case where the last picture was obtained from two RF coils was explained, the extension into the case where RF coil is three or more is as follows. That is, K is defined between 1st RF coil and 2nd RF coil, desired f (K) is determined, K' is similarly defined between 1st RF coil and 3rd RF coil, and desired g (K') is determined. In addition, g (K') does not need to be the same type as f (K).

[0053] For example, in M=W1M1+W2M2+W3M3, if you want to carry out like <f[M>=] (K) g (K') <M1>, W1 like following formula (15) - (17), W2, and W3 will be defined.

[0054]

[Mathematical formula 13]

$$W1 = \frac{f(K)\, g(K')}{1 + K^2 + K'^2} \qquad \cdots (15)$$

[0055]

[Mathematical formula 14]

$$W2 = \frac{K\, f(K)\, g(K')}{1 + K^2 + K'^2} \qquad \cdots (16)$$

[0056]

[Mathematical formula 15]

$$W3 = \frac{K'\, f(K)\, g(K')}{1 + K^2 + K'^2} \qquad \cdots (17)$$

(e) Although the case where it was considered as a calculation processing procedure equivalent to the Arinobu number field also with the non-signal field of a subject which only noise almost occupies was explained, by SURESSHU hold processing (threshold processing) of a signal level etc., a non-signal field may be extracted and you may constitute as another processing procedure. As another processing procedure of a non-signal field, or it makes the signal value of this field into zero, for example, you may constitute so that it may compound by the sum OBU square method or may be considered as the value which interpolated K of the Arinobu number field as K of this field.
(f) the 1st RF coil C1 has uniform sensitivity distribution -- the last composition picture -- this -- although the case where it was made the same sensitivity distribution as the 1st RF coil C1 was explained even if sensitivity distribution of the 1st RF coil C1 is uneven -- this -- [a means to acquire the sensitivity distribution S of the 1st RF coil C1 (for Suffixes i and j to omit) / provide and] If the system which reconstructs a picture can know the sensitivity distribution S which this means acquired (you may register in advance), instead of M1 [with M1' of the following formula (18)] The reconstruction picture of a too uniform sensitivity distribution pattern can be obtained by applying a formula (1), (10), and (11), and being referred to as f(K) =1.
[0057] M'=M1/S1 -- when the sensitivity distribution information on RF coil of any 1 can know apart from the data based on a scan among (18), i.e., two or more RF coils which carry out concurrent use the base obtained from the RF coil -- the base which can obtain the sensitivity distribution pattern of a picture from uniform RF coil -- it can do like the sensitivity distribution pattern of a picture. after an appropriate time -- the base after correction -- the base obtained with uniform RF coil in the picture -- it can treat as a picture and the last picture which has the sensitivity distribution pattern of an arbitrary request can be further obtained by making f (K) into the function of an arbitrary request.
(g) This embodiment explained with the magnetic resonance imaging system supposing the absolute value picture (magnitude picture) generally used. However, this invention can be applied also when M, M1, and M2 are a real picture and an IMAJINARI picture fundamentally. To apply to a real picture or an IMAJINARI picture, in the field where a non-signal part or a signal is weak, <M1> and <M2> need to take into consideration that it is easy to become zero. Even if it uses the value of C big [even if], since M1 and M2 have a mark, suitable M cannot be obtained. Then, as (e) described, a low signal field is extracted and it is desirable about the field concerned to take special measures. For example, K of a low signal field is interpolated from K of the Takanobu number field.
(h) Moreover, this embodiment explained supposing M1, M2, and -- having comparable noise standard deviation respectively. However, noise standard deviation does not necessarily

become comparable with each RF coil by a difference and others of the profit of the preamplifier connected to each RF coil. in that case, the case where the number of RF coils is two, for example -- M1, noise standard deviation sigma1 of M2, sigma2, or the ratio of those -- what is necessary is to acquire alpha (sigma2=sigma1andalpha) and just to use M2/alpha instead of M2

(i) In addition also in the sum OBU square method, each RF coil is premised on having comparable noise standard deviation. What is necessary is just to use M2/alpha instead of M2 like (h) also in the sum OBU square method, in order to cope with the variation in noise standard deviation.

the ratio of the noise standard deviation of each RF coil in (j), (h), and (i) -- although alpha obtained by having measured separately as a means to ask for alpha may be registered into a system, that is not right, and it is convenient if you perform it as follows. That is, the amplitude of k space data in the corner parts S1-S4 (place where the amount of the amount of phase encodings and frequency encodings is also large) of k space shown in drawing 8 tends to be governed with noise rather than MR signal from a subject. Then, let standard deviation of the absolute value of k space data of a corner part be the quantity proportional to noise standard deviation sigmaof M11 among k space data of the 1st RF coil C1.

[0058] It asks for the standard deviation of the absolute value of k space data of a corner part as a quantity proportional to noise standard deviation sigmaof M22 among k space data similarly, and these ratios (sigma2/sigma1) are set to alpha.

[0059] in addition -- temporary -- base -- when what (there is no source of a signal) a subject does not exist in a picture M1 and the corner portion of M2 is separately understood with a certain means, it has the ratio of the standard deviation of the value of the corner part concerned, and is good also as alpha. base -- if it is an absolute value picture instead of asking for alpha by the ratio of the noise standard deviation of the corner part of a picture -- base -- since it is known that there is a fixed relation, the average value and noise standard deviation of a corner part (non-signal part) of a picture are the thing same also as alpha with the ratio of the average value of a corner part (non-signal part).

(k) in the above explanation -- composition of the last picture -- once -- base -- calculating a picture M1 and M2 -- this -- it explained as compounding M1 and M2. As other synthetic methods, you may compound, for example on k space as follows. That is, first of all, M1 and M2 are reconstructed by a coarse picture matrix from k space data. next, K which computed and computed the global distribution K of the signal strength ratio from M1 reconstructed and M2 -- this -- the dignity W1 and W2 which are expressed by arbitrary functions [of K] f (K) are computed. And new k space data of 1 is obtained by adding new k space data which performed combo RYUSHON calculation respectively to k space data of 1st and 2nd RF coil, and obtained function F [W1] which obtained them by having carried out Fourier inverse

transform of this W1 and W2, and F [W2] by this calculation. If the Fourier transform of this k space data is carried out, the last composition picture can be obtained.

[0060] In addition, separately, by a means, since the ratio is equal to K in a known case, the sensitivity distribution pattern of 1st and 2nd RF coil does not once need to reconstruct M1 and M2 by a coarse picture matrix.

(l) if it hits in quest of K -- base -- although the case where it asked after smoothing a picture M1 and M2 was explained, since what is necessary is just to remove the influence of noise from K in short, it is good also considering what asked for K, with M1 and M2 not smoothed, and smoothed it as final K.

(m) although it weaves in that this embodiment aligns the global sensitivity distribution pattern of a synthetic picture with the global sensitivity distribution pattern of the 1st RF coil C1 into picture composition processing the usual image reconstruction -- base -- once obtaining a picture M1 and M2 and obtaining the synthetic picture M by a method like the after that usual sum OBU square method, you may constitute so that this synthetic picture M may be amended. That is, M1 and M obtained for example, by the sum OBU square method are smoothed with the smoothing function of the same characteristic, and <M1> and <M> are obtained. And <M>/<M1> is obtained. M", then M " of global sensitivity distribution patterns become being the same as that of <M1> about the result of having broken M by <M>/<M1>.

(n) two or more base -- in smoothing a picture, it explained having used the common smoothing function. However, this invention is theoretically applicable even if it uses different smoothing functions. However, since distortion arises in the edge portion in which the signal level in a photographic subject changes suddenly in this case, about the edge portion of <M>/<M1> of K or a modification (m), interpolating from other than an edge portion is appropriate. This invention cannot be limited to the embodiment mentioned above, but can change variously, and can be carried out.

[0061]

[Effect of the Invention] As explained above, according to this invention, the magnetic resonance imaging system with which the following effects are acquired can be offered.

(1) Even if it does not provide a means to add restriction to the installation position of RF coil, and direction, or to detect this, a uniform picture can be highly compounded by the best SNR, and the handling of equipment and observation of a picture are easy. Moreover, it becomes diagnosable easily, a patient throughput improves, and operation cost reduces a high-definition picture.

[0062] (2) Since it is not necessary to carry out concurrent use of two or more RF coils, and to take a photograph in two or more steps, speed of photography can be made quick. Moreover, although SNR is high, since a homogeneous good picture can be photographed and SNR can reduce the number of times of a high part and an addition average, securing the SNR even if

sensitivity homogeneity uses bad RF coil, photography time can be shortened.
[0063] (3) SNR of the part whose SNR improved, and the grade which has also made the pixel small is maintained, and the resolution of a picture can be improved.
(4) A window can be changed frequently, it is not necessary to observe a picture and, the number of the hard copies for it can also decrease, and an operator's burden can be eased by that which can observe an extensive field at once and exists in the same window.

[Brief Description of the Drawings]
[Drawing 1] The figure showing the outline composition of one embodiment of the magnetic resonance imaging system by this invention.
[Drawing 2] Graph which shows signal strength distribution of the picture which starts the above-mentioned embodiment and is obtained with the 1st RF coil C1 in three dimensions.
[Drawing 3] Graph which shows signal strength distribution of the picture which starts the above-mentioned embodiment and is obtained with the 2nd RF coil C2 in three dimensions.
[Drawing 4] Graph which shows signal strength distribution of the picture obtained after starting the above-mentioned embodiment and smoothing the data of the 1st RF coil C1 in three dimensions.
[Drawing 5] Graph which shows signal strength distribution of the picture obtained after starting the above-mentioned embodiment and smoothing the data of the 2nd RF coil C2 in three dimensions.
[Drawing 6] Graph which starts the above-mentioned embodiment and shows the global distribution K of a signal strength ratio in three dimensions.
[Drawing 7] Graph which starts the above-mentioned embodiment and shows signal strength distribution of the last composition picture in three dimensions.
[Drawing 8] The figure in which starting the above-mentioned embodiment and showing the corner part of k space.
[Drawing 9] The figure showing typically two or more RF coils which are applied to the above-mentioned embodiment and collect MR signals from a subject simultaneously.
[Drawing 10] Graph which shows signal strength distribution of the picture obtained in the state where there is no noise when imaging of the AKISHARU section of Subject M is completely carried out with uniform RF coil in three dimensions.
[Drawing 11] Graph which shows signal strength distribution of the picture obtained by the sum OBU square method which is the conventional picture synthetic method in three dimensions.
[Explanations of letters or numerals]
1 -- Static magnetic field magnet,

2 -- The X-axis, the Y-axis, and Z shaft inclination slanting magnetic field coil,

3 -- ****** coil,

4 -- Static magnetic field control device,

5 -- Transmitting machine,

6 -- Receiver,

7 -- X shaft inclination slanting magnetic field power supply,

8 -- Y shaft inclination slanting magnetic field power supply,

9 -- Z shaft inclination slanting magnetic field power supply,

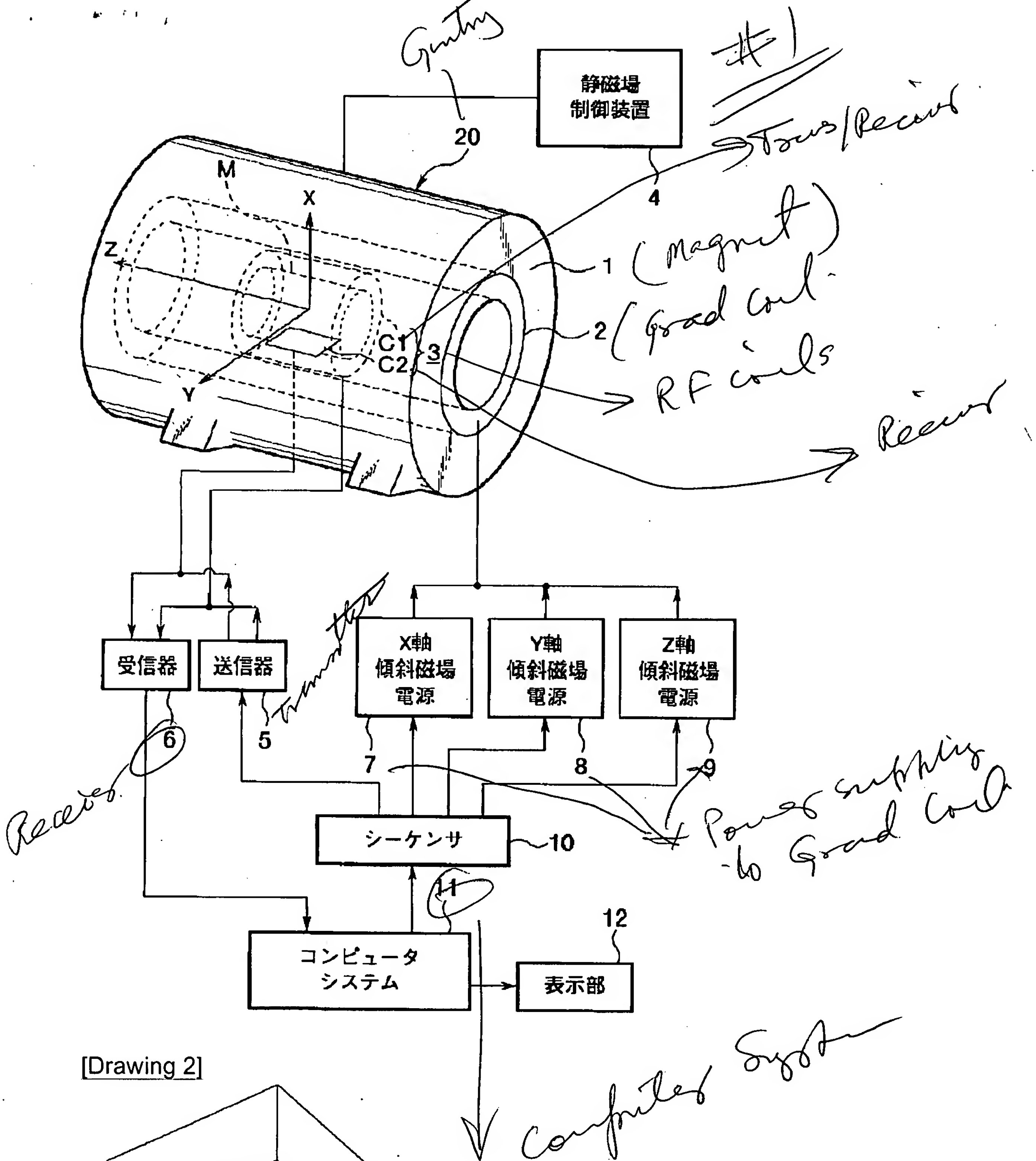
10 -- Sequencer,

11 -- Computer systems,

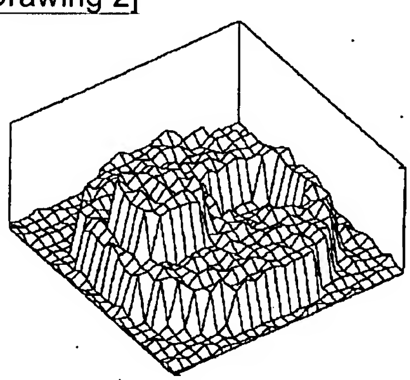
12 -- Display part,

20 -- Gantry.

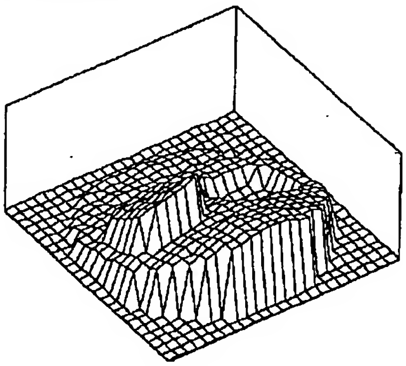
[Drawing 1]


静磁場
制御装置
20
4
M
X
Z
Y
L
1
2
3
C1
C2
受信器
送信器
6
5
X軸
傾斜磁場
電源
Y軸
傾斜磁場
電源
Z軸
傾斜磁場
電源
7
8
9
シーケンサ
10
11
コンピュータ
システム
表示部
12
Gantry
#1
Trans/Receiv
(Magnet)
(Grad Coil
RF coils
Receiver
Transmitter
Receiver
Power supplying to Grad Coil
Computer System

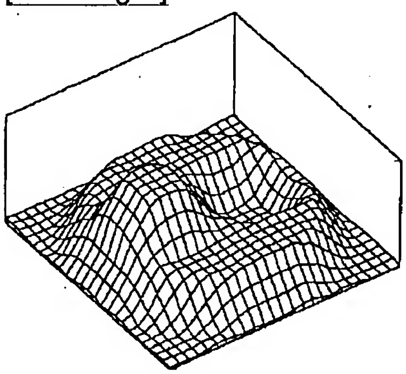
[Drawing 2]



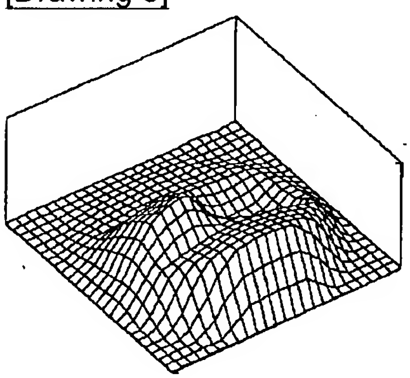
[Drawing 3]



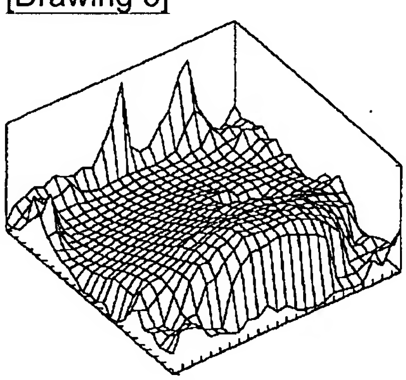
[Drawing 4]



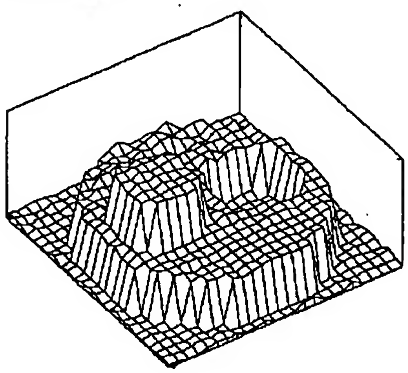
[Drawing 5]



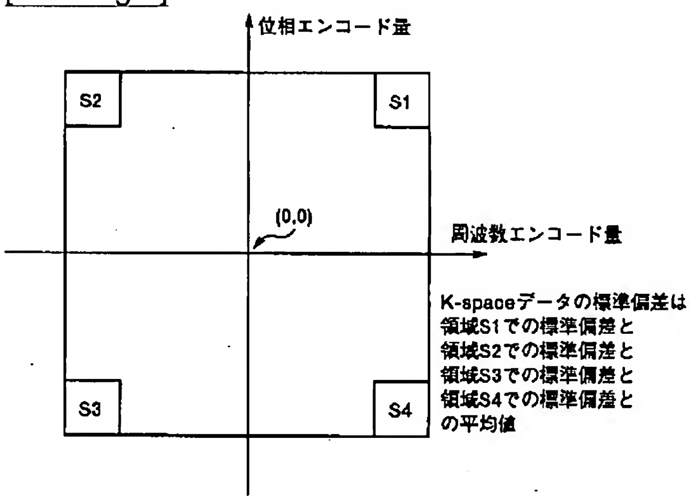
[Drawing 6]



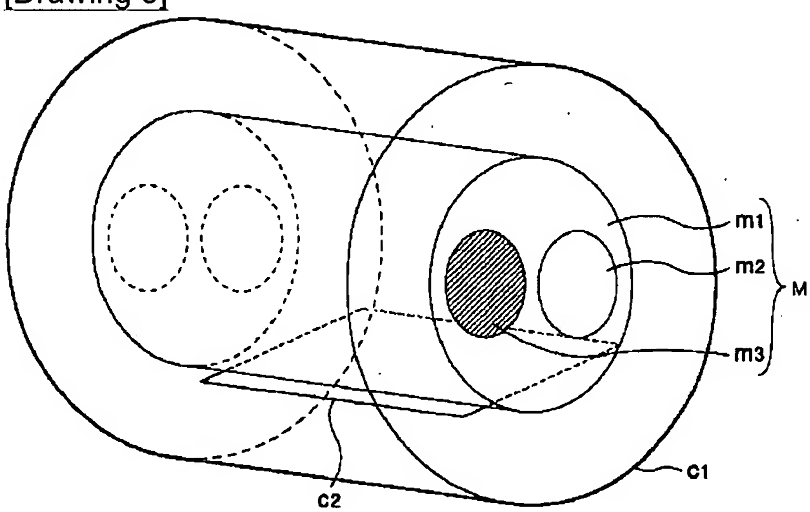
[Drawing 7]



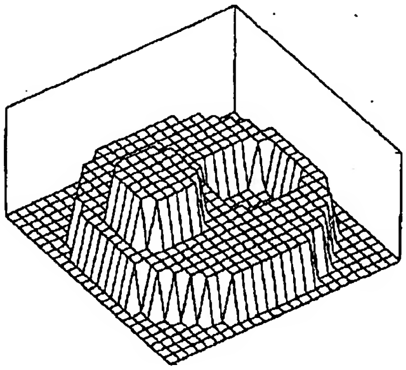
[Drawing 8]



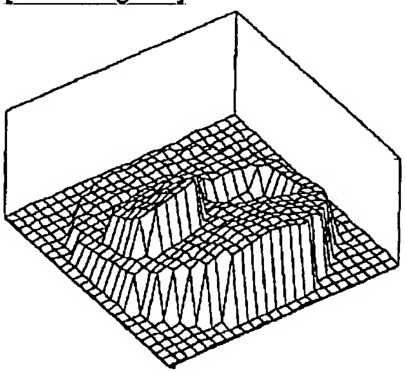
[Drawing 9]



[Drawing 10]



[Drawing 11]



[Translation done.]